21 October 2005 panoramas

BBHRP Assessment Using Ground and Satellite-based High Spectral Resolution IR: Update on TOA

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ARM STM Topics/ IRF Update

A. Project Goal/Objectives, Approach, and Tasks

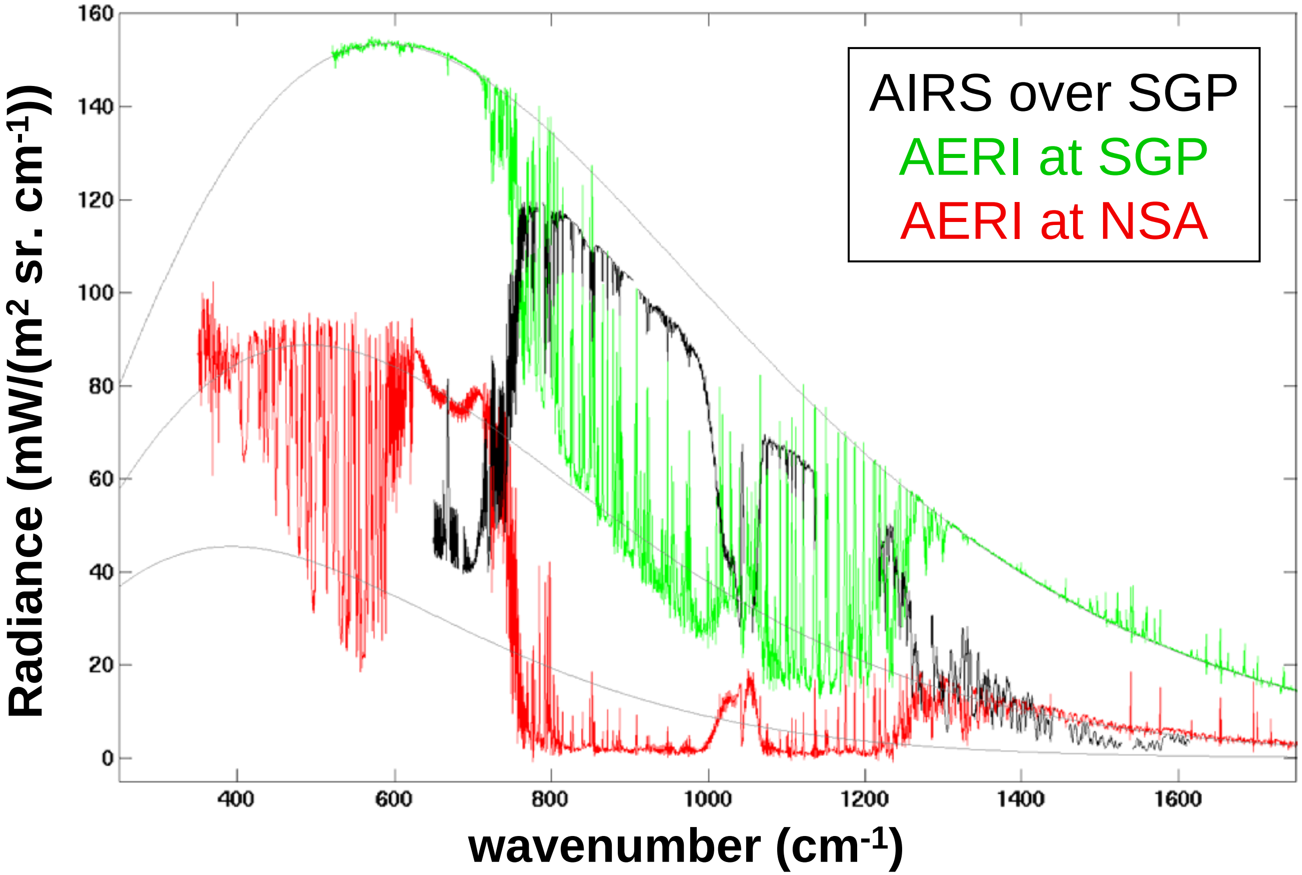
B. TOA using AIRS (9/2002-3/2005, Clear sky)
   - AIRS-LBLRTM radiances
   - AIRS Surface Properties
   - GOES Fluxes compared to RRTM (with AIRS Surface Properties)

C. Surface (2000-2005, Clear Sky)
   - AERI-LBLRTM radiances
   - Pyrgeometer Fluxes compared to RRTM

D. Future Plans

Backup: AIRS - Scanning HIS comparisons

Use of High Spectral Resolution Data



New thrust is applying high resolution from Space to ARM/BBHRP (NASA AIRS on Aqua, Eumetsat IASI on Metop)

Project Approach

- **AIRS and AERI high spectral resolution TOA and surface radiances together strongly constrain atmospheric heating/cooling rates, lower and upper level atmospheric water vapor and temperature, clouds, and surface properties. We use this information to assess the accuracy of the BBHRP inputs, RT calculations, & parameterizations.**
- **Derive products consistent with observed radiance spectra, including**
  - Refined cloud properties (surface and TOA)
  - Upper level moisture distributions (TOA)
  - Detailed surface properties (TOA)
  - Radiation constraints over extended GCM grid cells (TOA)
- **Special strengths of high resolution with broad spectral coverage:**
  - Better sensitivity & heights for low optical depth clouds
  - Nighttime and low-sun cloud and surface properties
  - Better isolation of upper level water vapor influencing TOA flux
  - More compete spectral coverage
- **Scanning HIS is used to validate satellite radiances & algorithms**
- **Phasing: Clear SGP-CF to establish tools (extension and refinement of current results covering 1996-2006), proceed to cloudy SGP-CF, then NSA, TWP, AMF, and finally to the grid cell scale for each**

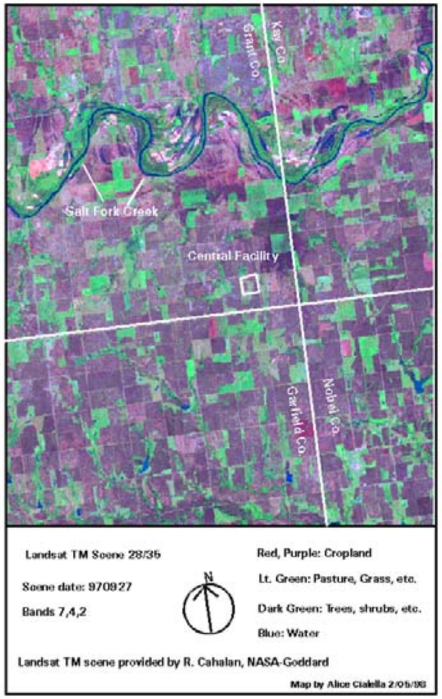
New TOA Cases using AIRS

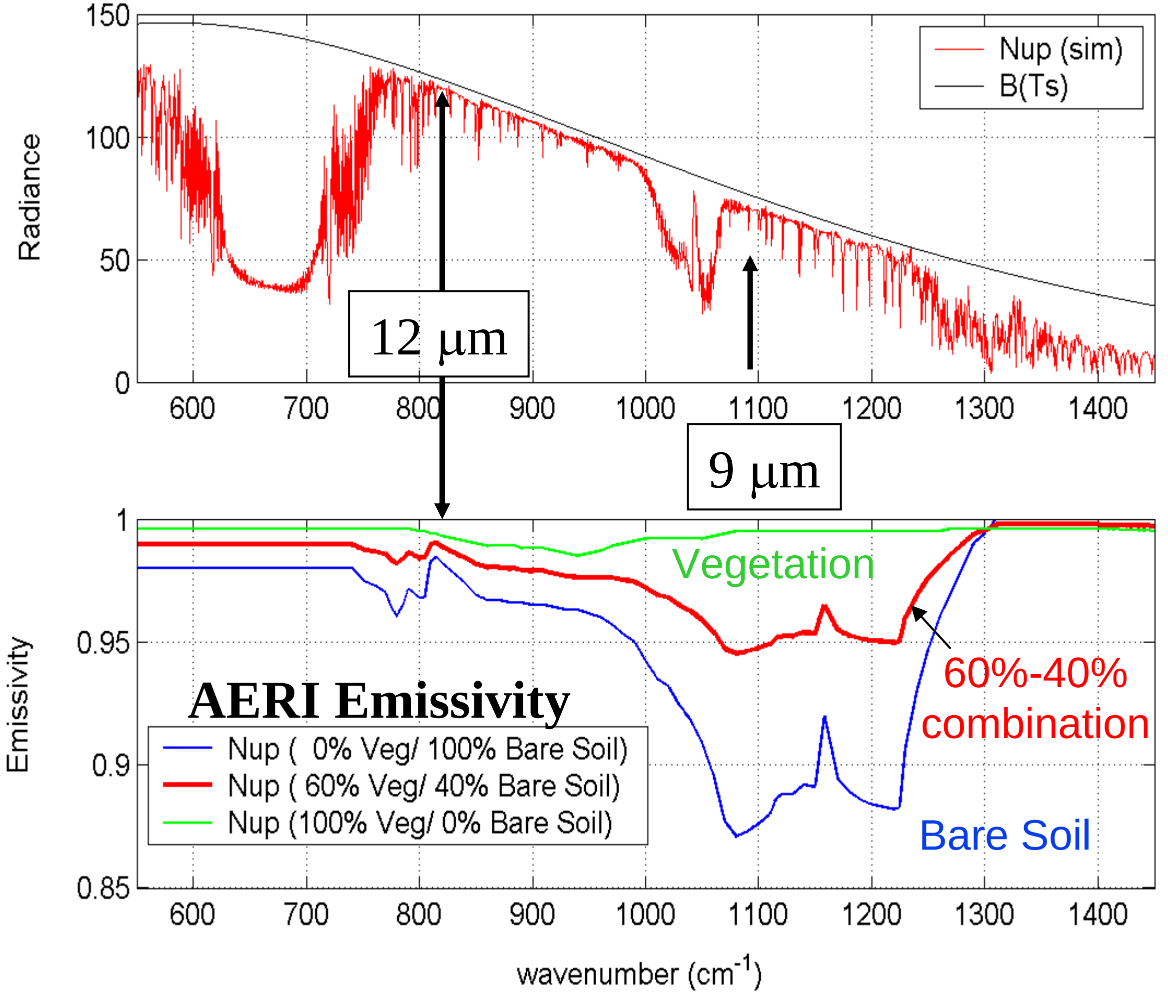
Sept 2002-March 2005

- Radiance & flux calculations performed for all overpasses (clear and cloudy conditions, no constraint on RAOB timeliness, allowing evaluation of selection criteria)
- More AIRS data available in data sets
- Stratosphere uses ECMWF with cold bias correction

Characteristic	1st Cut-ARM STM	Now- IRF
AIRS overpass criteria for LBLRTM and RRTM calculations	Clear only, for AIRS 3x3 FOV groups with center within 50 km of SGP CF	All AIRS 3x3 FOV groups with center within 50 km of SGP CF
Number of clear cases	3,253 Total, 1,905 Day, 1,348 Night	15,389 Total, 7,190 Day, 8,199 Night
Clear criteria	ARSCL Cloud Mask, AERI MWR SD, and AIRS surface Properties (ε >1 cloudy)	ARSCL Cloud Mask and AIRS surface Properties
AIRS data included	Mixture of versions and L1B files providing limited AIRS products	Version 4 with retrievals, surface T & emissivity, and cloud fraction by FOV
Atmospheric State below 70 mb	RAOBS within 1 hour of overpass, microwave scaled WV	Temporal interpolation of bounding RAOBS, microwave scaled WV
Atmospheric State 70 - 0.1 mb	US Standard Climatology-fixed	ECMWF with cold bias correction from MIPAS
Atmospheric State 0.1 - 0.005 mb	US Standard Climatology-fixed	US Standard Climatology-fixed
Ozone	TOMS total column, US Standard profile shape	TOMS total column, US Standard profile shape
Surface Temperature and Emissivity	Fit AIRS for vegetated fraction	Fit AIRS for vegetated fraction

Surface properties from AIRS using AERI-observed surface emissivity



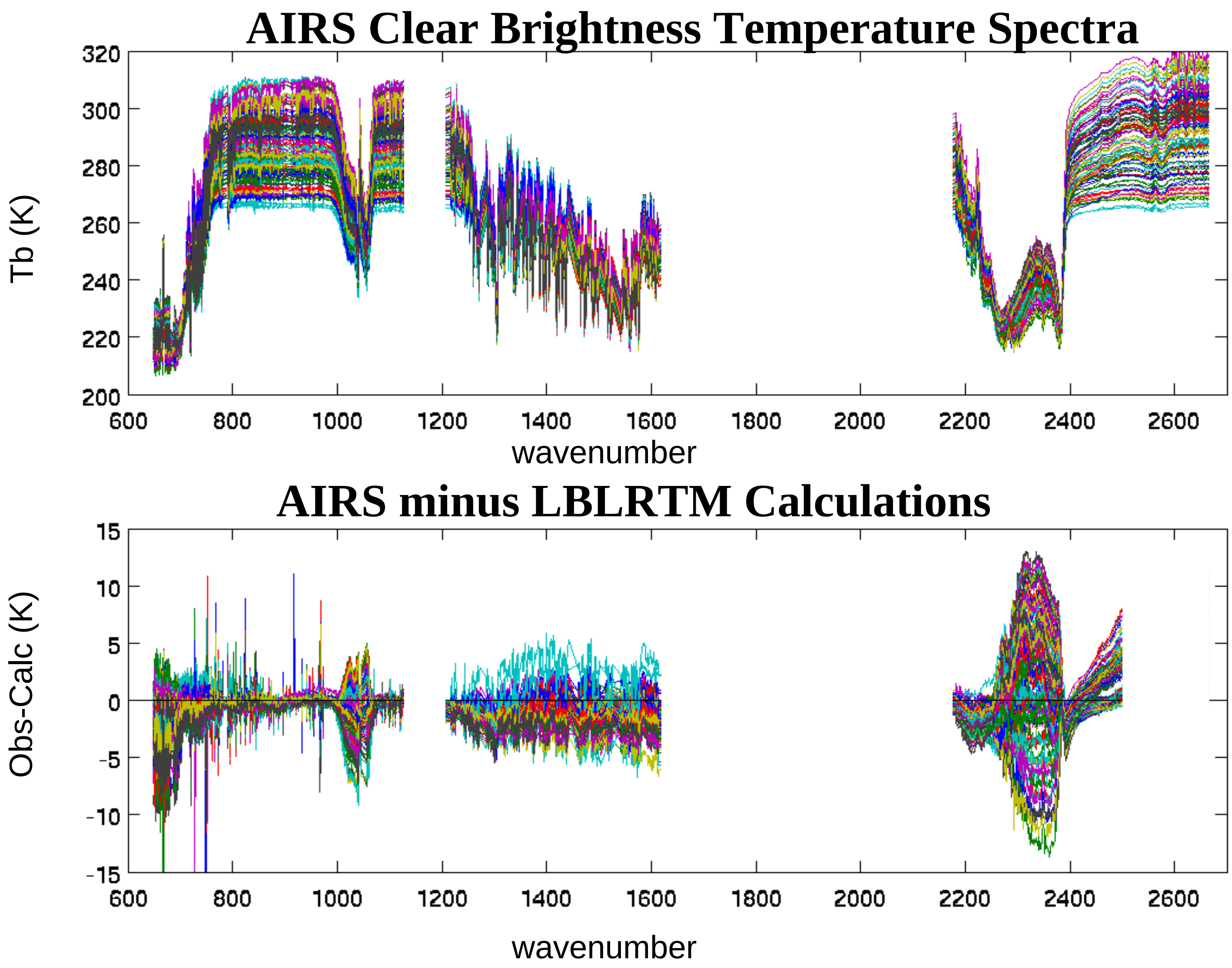


Technique

Surface Temperature from assuming emissivity ε (12 µm) = 0.985

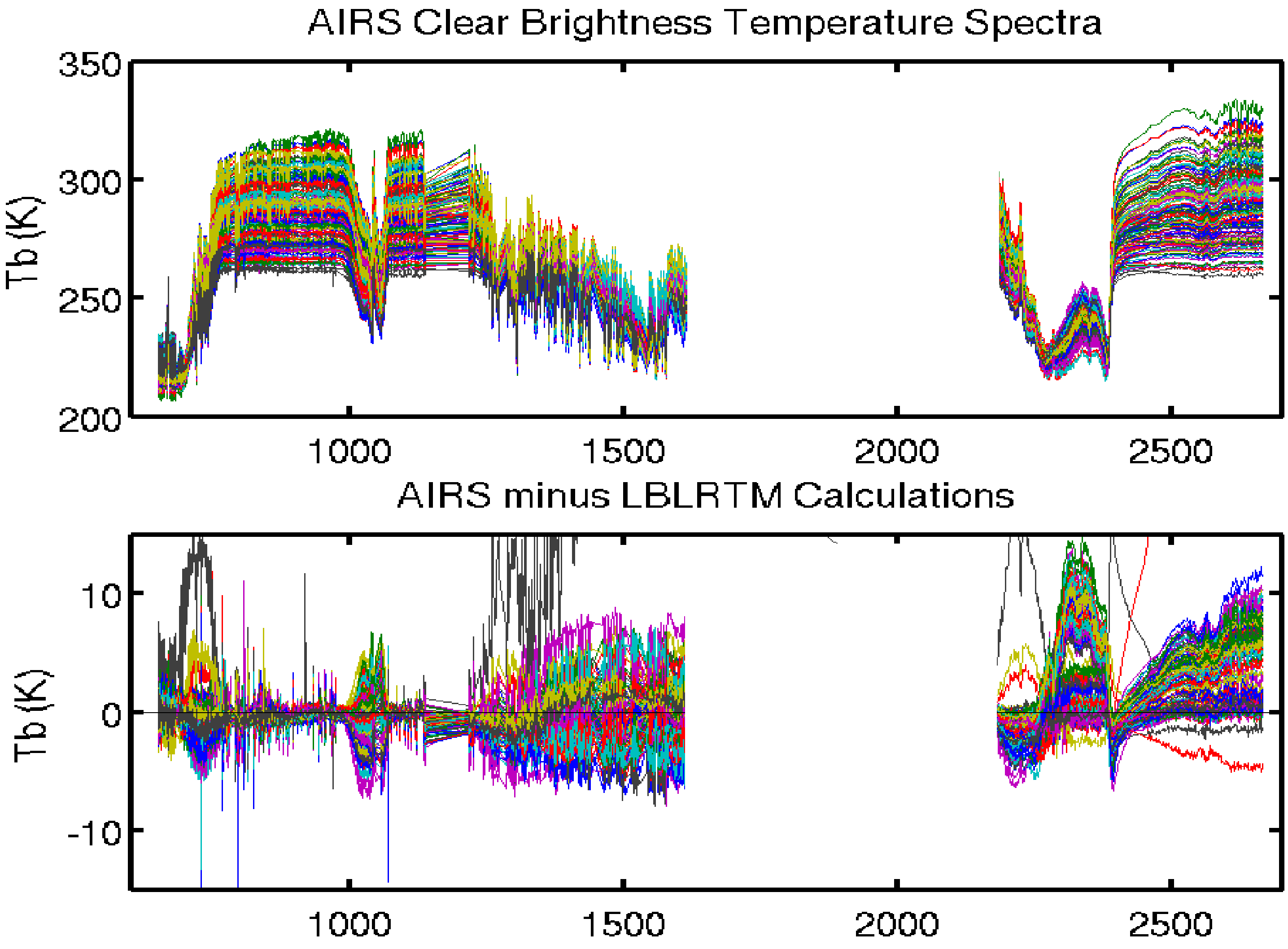
Vegetation Fraction from fitting linear combination of Bare Soil and Vegetation 9 µm radiance

Clear Sky AIRS minus LBLRTM

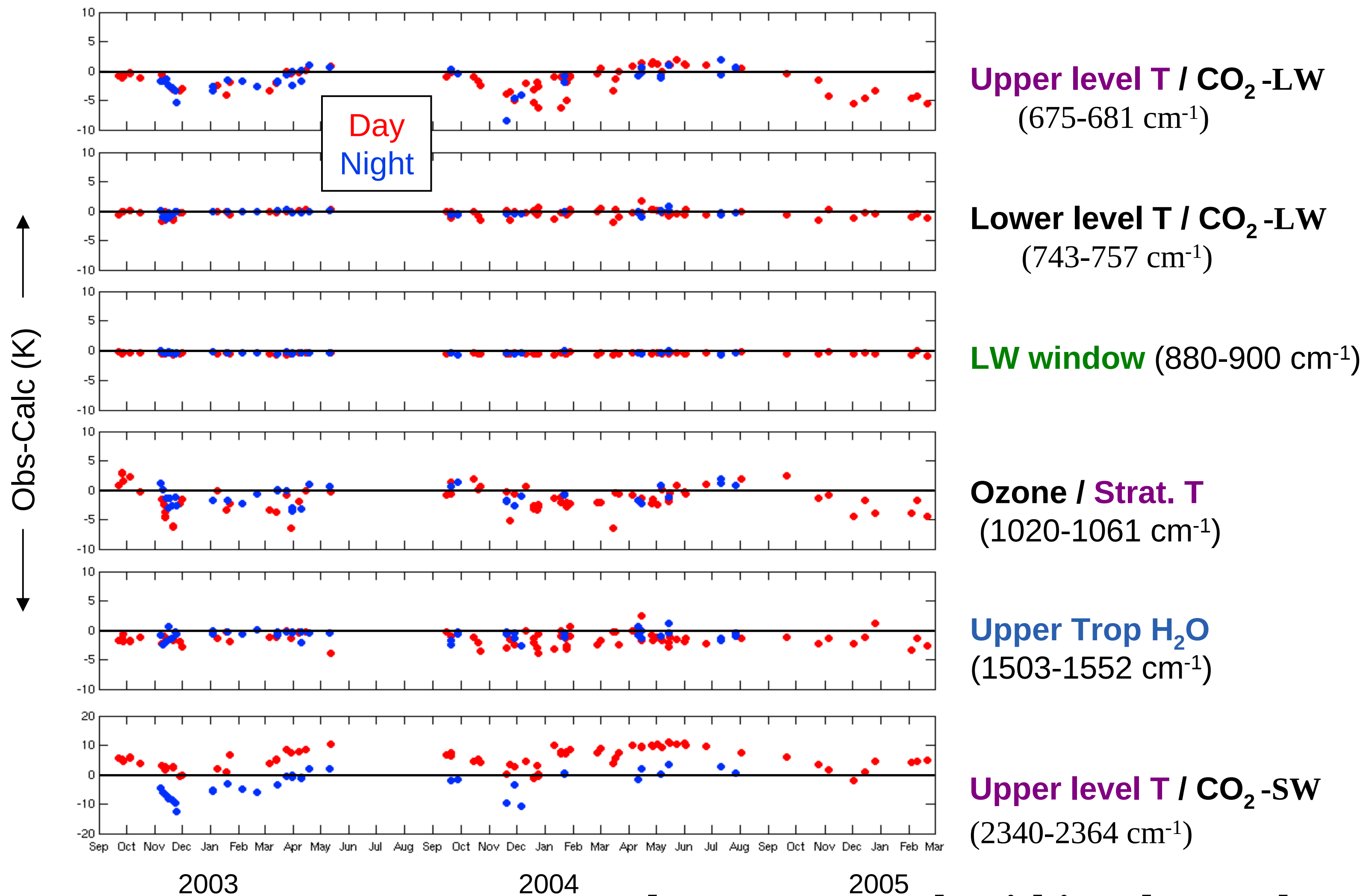


New Clear Sky AIRS minus LBLRTM

Now 15k clear sky profiles- subset shown



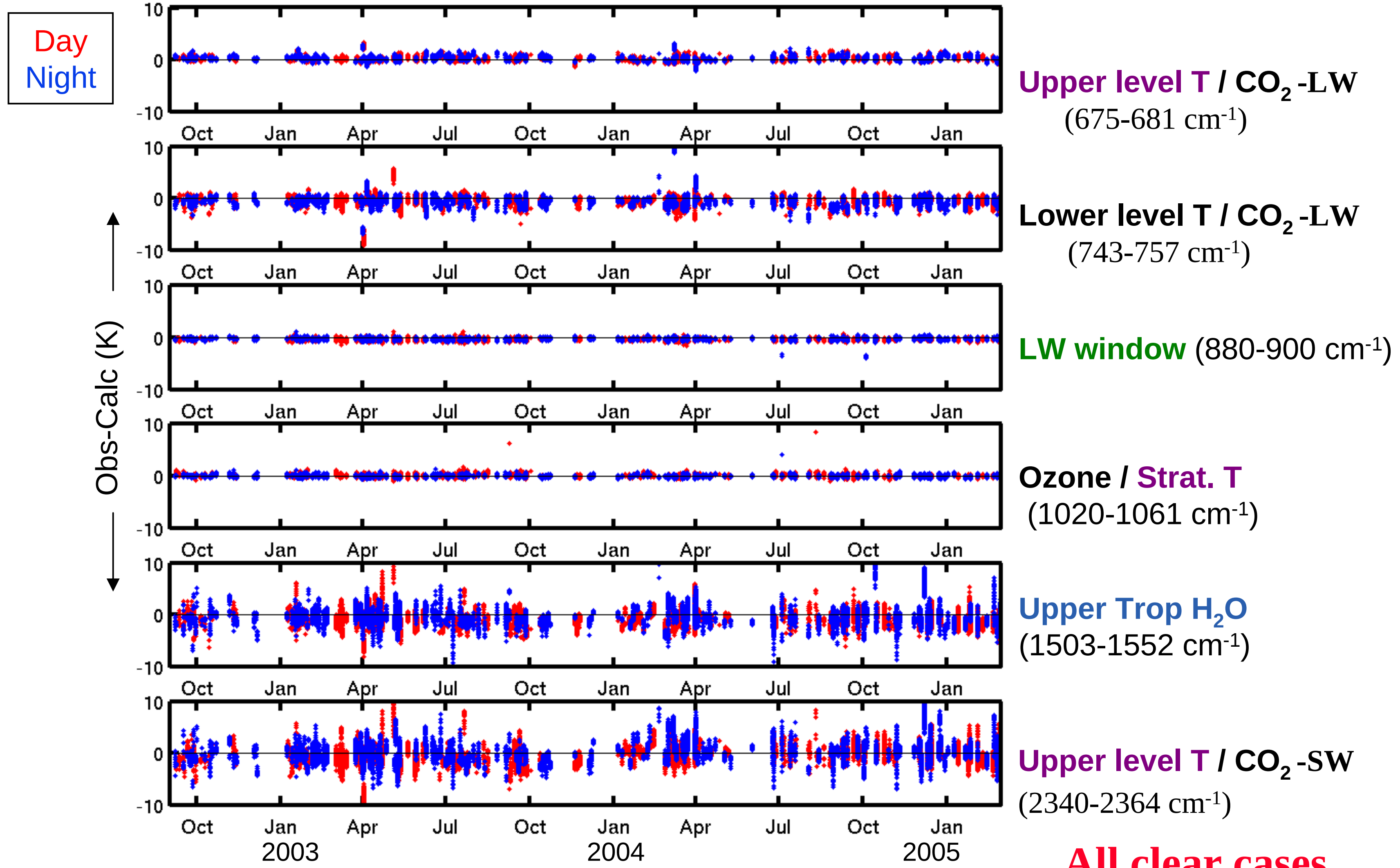
Time Series of AIRS-Calc for various spectral regions



Clear cases, Raob within 1 hour, closest FOV

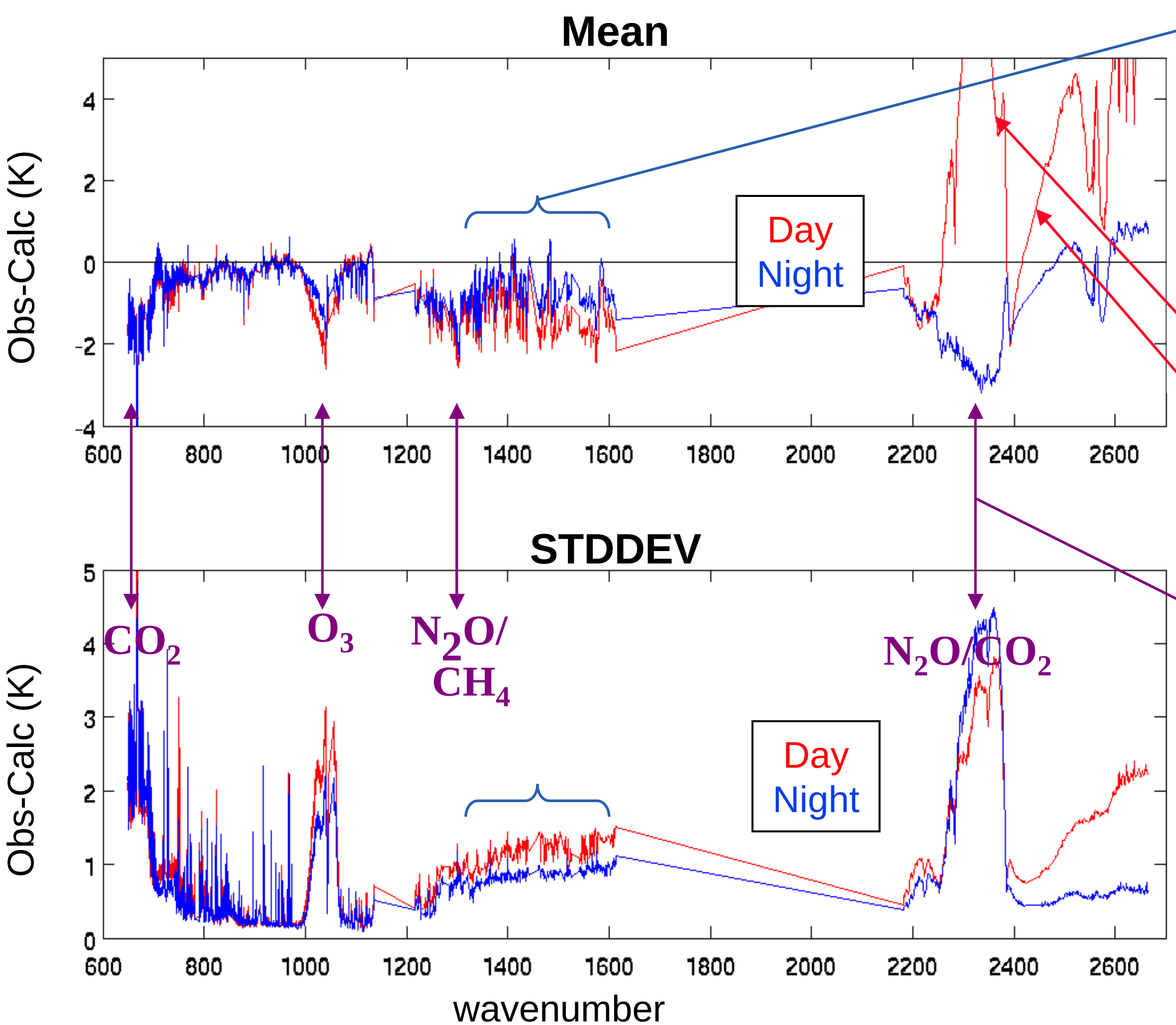
New Time Series of AIRS-Calc

Upper level T & O_3 much better



All clear cases

AIRS minus LBLRTM, Mean & SD



Upper level H_2O vapor

+1 K T_b is order

15% dry above 7 km

~ +1 W/m^2

Daytime

Non-thermo. Equilib &

Reflected solar

Temperature above sondes

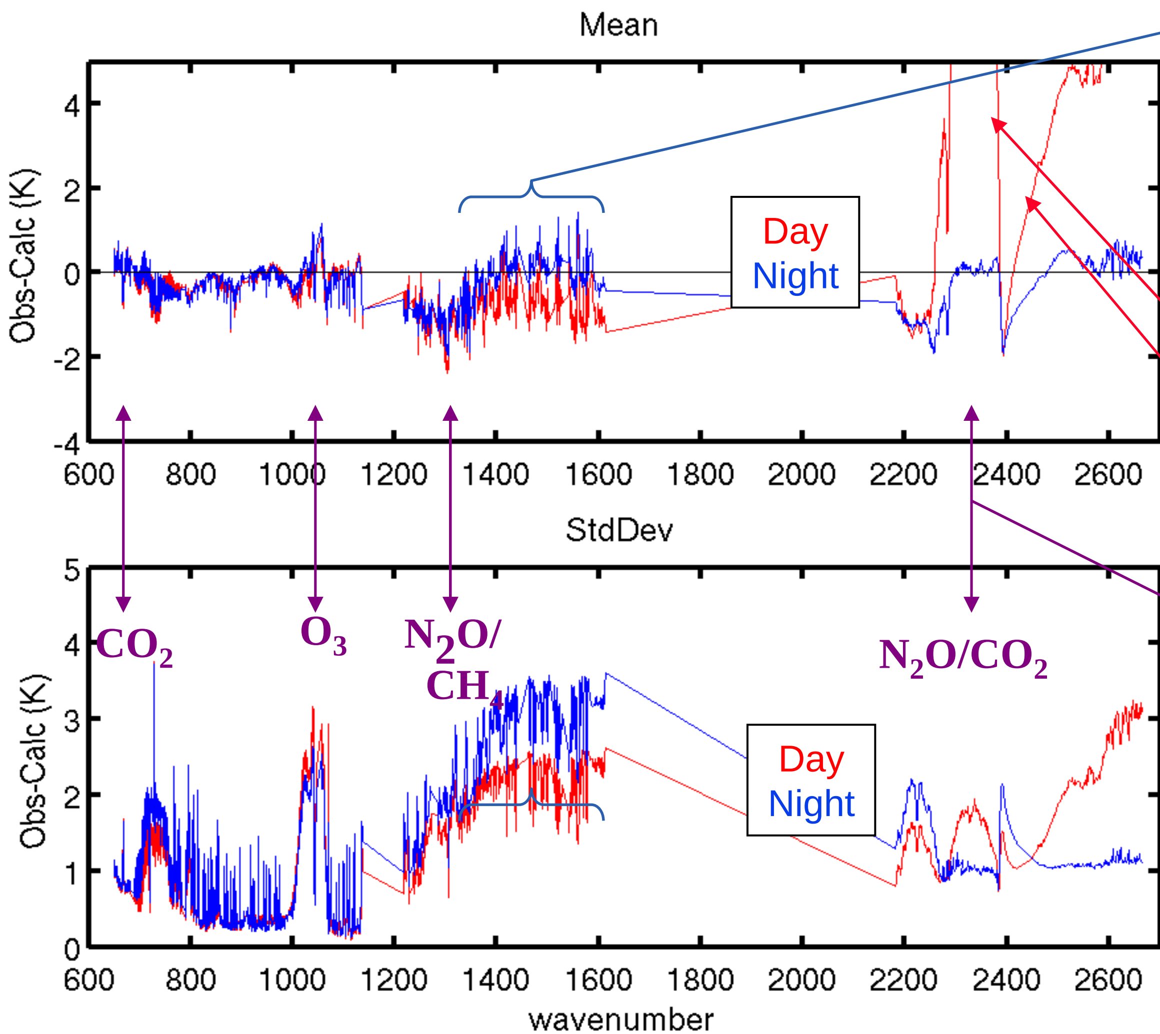
uses Climatology-

Plan to test with

AIRS retrievals

New AIRS minus LBLRTM, Mean & SD

Opaque region much better-
larger spatial/temporal differences increase SD for WV & T trop



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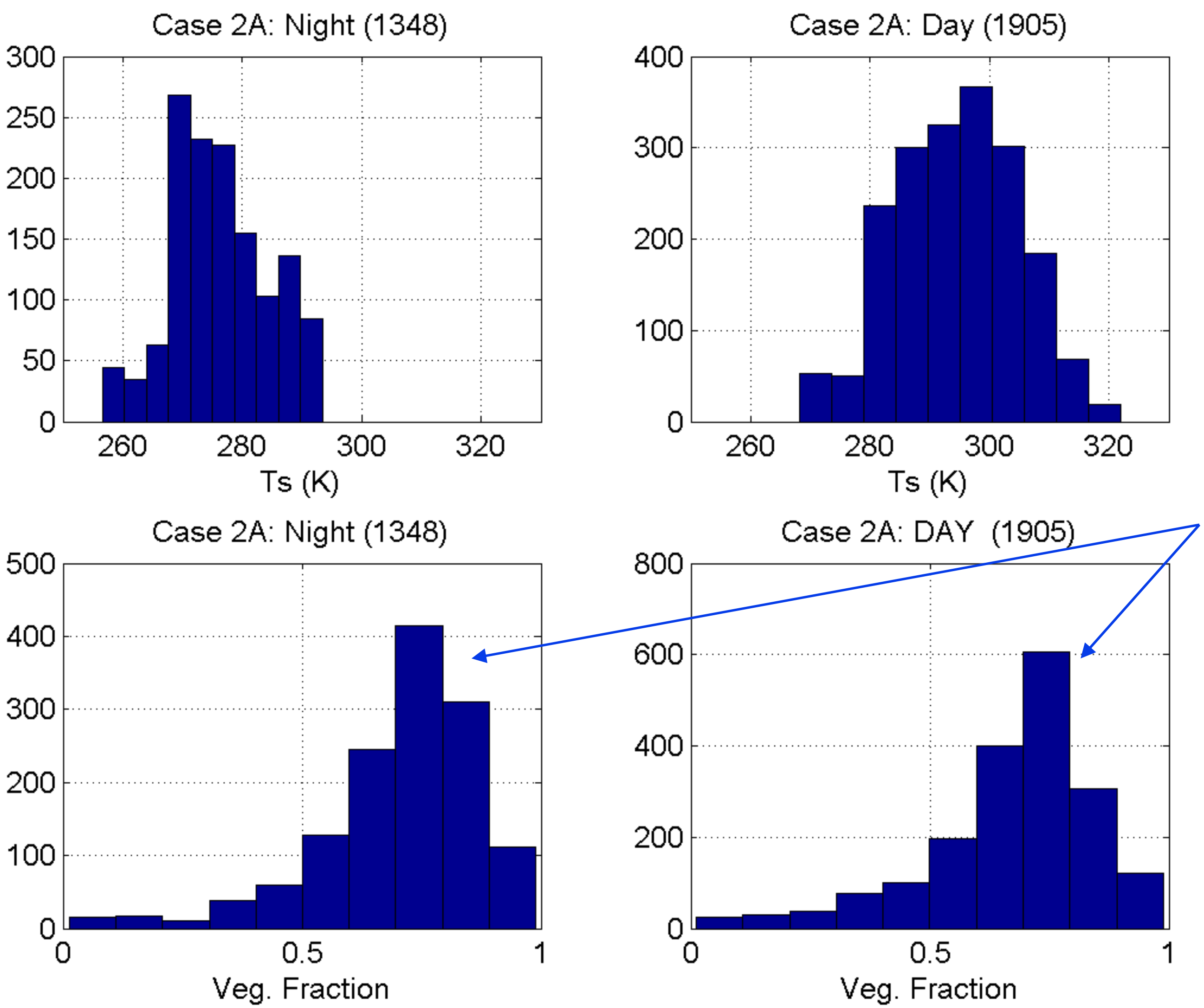
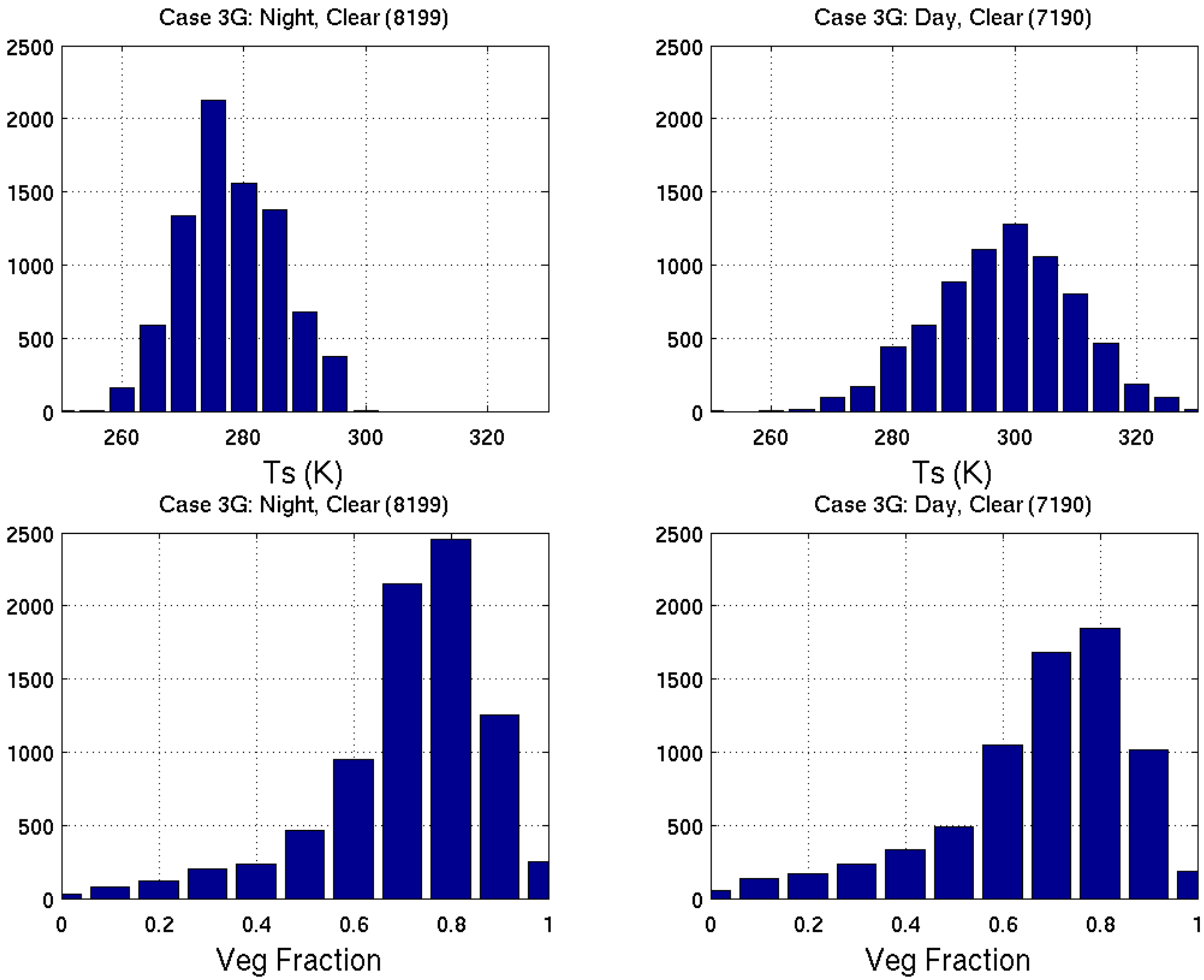
for cold bias

Surface temperature and Vegetation Fraction Distributions



Note similar Day & Night Vegetation Fraction from very different T_s distributions

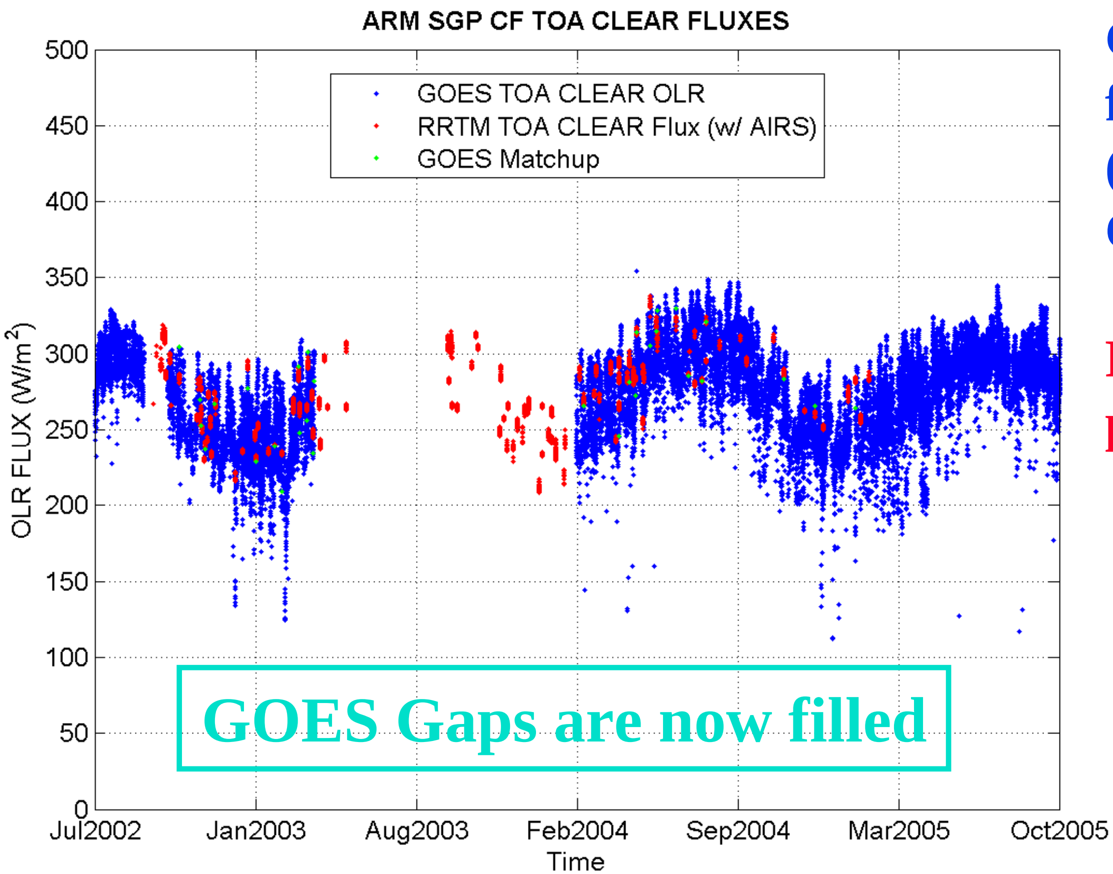
New Surface temperature and Vegetation Fraction Distributions



Ts more statistically representative

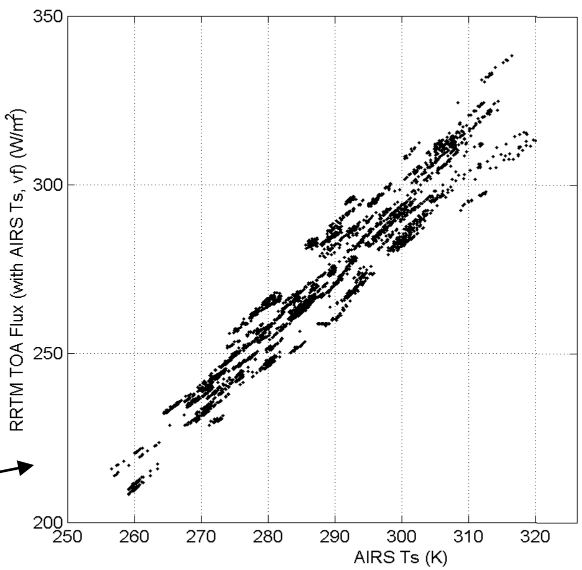
Maintains Vegetation Fraction distributions

Clear Fluxes: ARM SGP/CF TOA



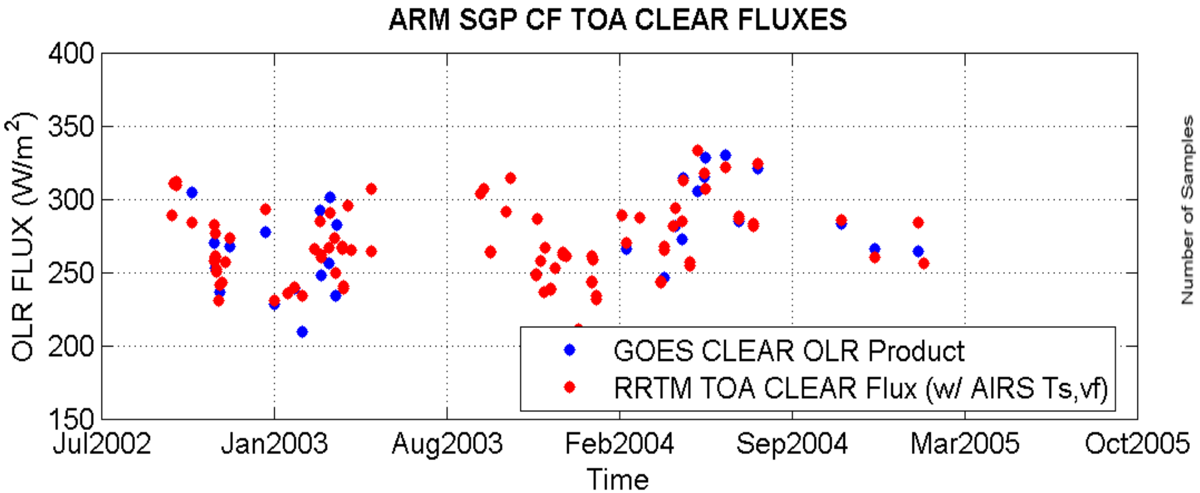
GOES Imager TOA flux from Pat Minnis' group (based on regression with CERES/ERBE radiances)

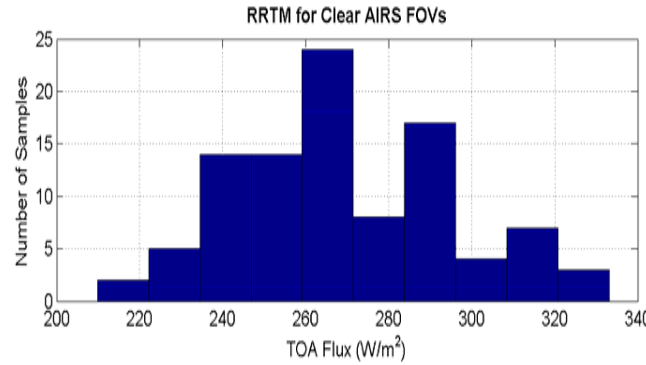
RRTM uses AIRS surface properties

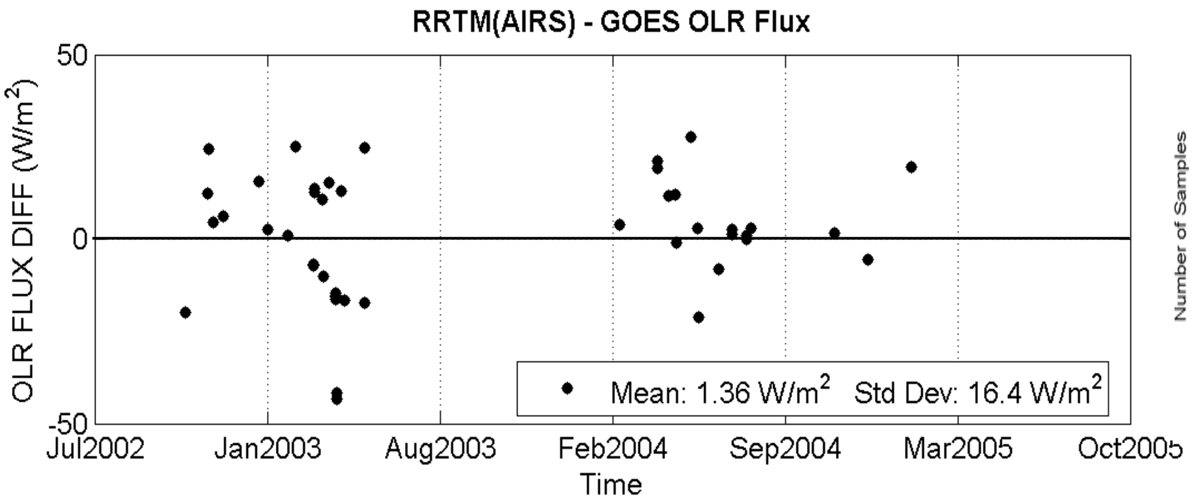


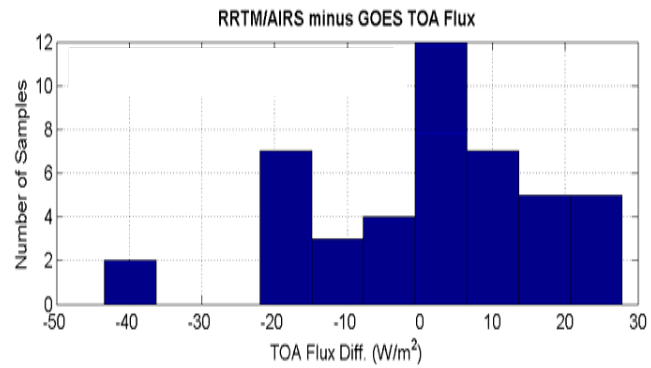
Clear flux strongly correlated with T_S

Co-located Clear Flux Comparison









GOES flux: within 10 km of CF & 1 hour of AIRS

In error— AIRS surface not actually included

AIRS surface properties: closest pixel (15 km diam)

Avg = 1.36 W/m^2
SD = 16.4
~p-p = 60

Progress/Status Summary

- Making progress on structure and nearing completion of clear sky baseline using AIRS surface information
- Found error in surface properties for previous flux calculations
- Ready to start handling Cloudy conditions, beginning with overcast SGP
- Will complete clear SGP (1996-2006) and extend to Arctic, Tropics, and AMF (Niger) central sites
- Still expect to add IASI morning data to AIRS PM when it becomes available
- Plan to add direct use of CERES data

Backup: AIRS - Scanning HIS comparisons

- Validate AIRS Radiance Absolute Calibration
- Demonstrate consistency with ARM radiances

UW Scanning HIS: 1998-Present

HIS: High Resolution Interferometer Sounder (1985-1998)

Characteristics

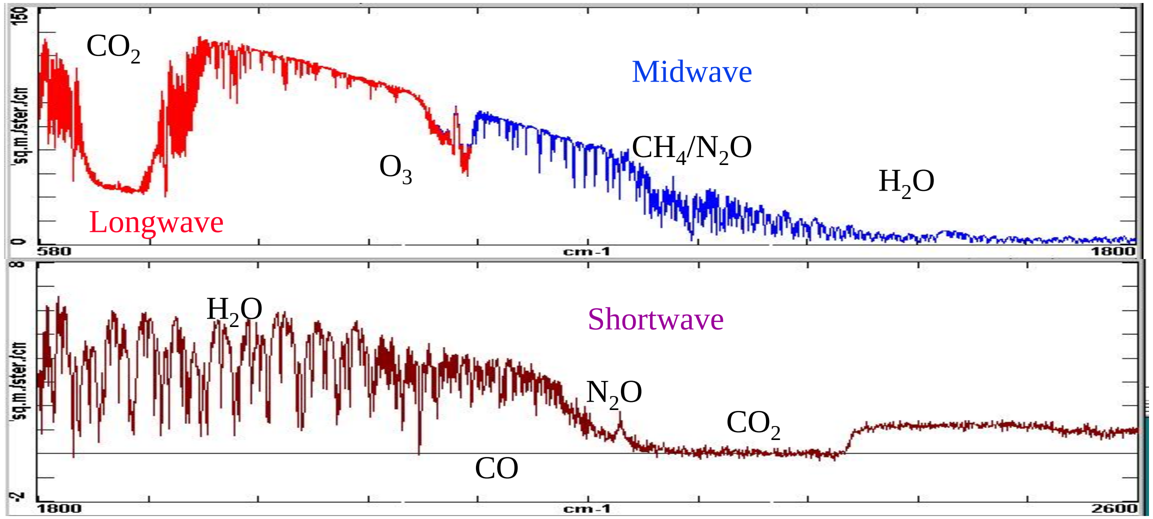
Spectral Coverage: 3-17 microns

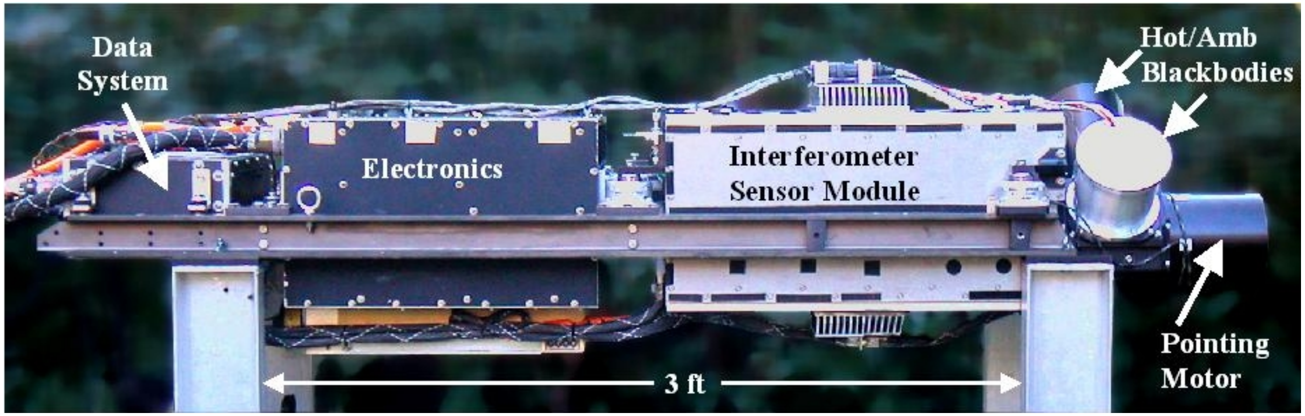
Spectral Resolution: 0.5 cm^{-1}

Resolving power: 1000-6000

Footprint Diam: 1.5 km @ 15 km

Cross-Track Scan: Programmable including uplooking zenith view

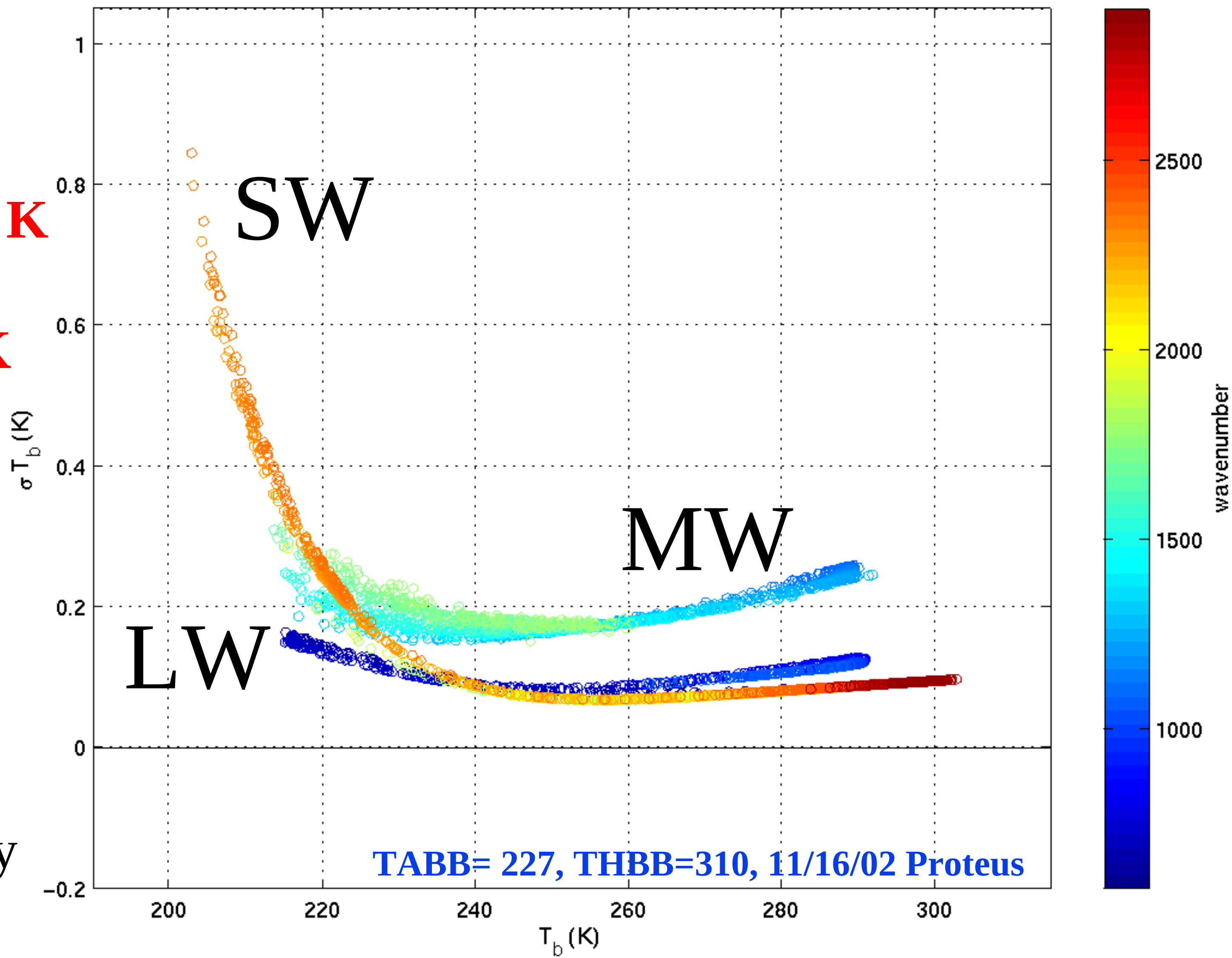




Applications:

- Radiances for Radiative Transfer
- Temp & Water Vapor Retrievals
- Cloud Radiative Prop.
- Surface Emissivity & T
- Trace Gas Retrievals

Scanning-HIS
Radiometric Calibration Accuracy
Similar to AERI description in Best, et al., CALCON 2003

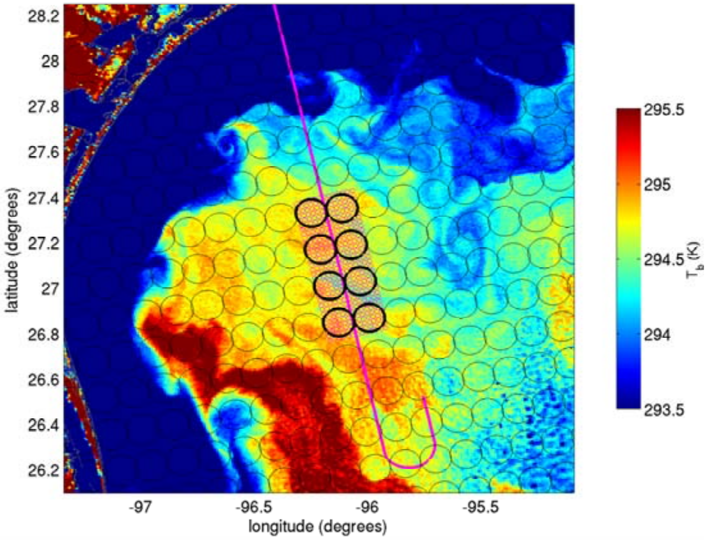


3-sigma Tb error mostly < 0.2 K for Tb >220 K

RSS of Errors in
T_{HBB}, T_{ABB}
T_{Rfl}
$\varepsilon_{HBB}, \varepsilon_{ABB}$
+ 10% of non-linearity correction

AIRS / S-HIS Comparison Methodology

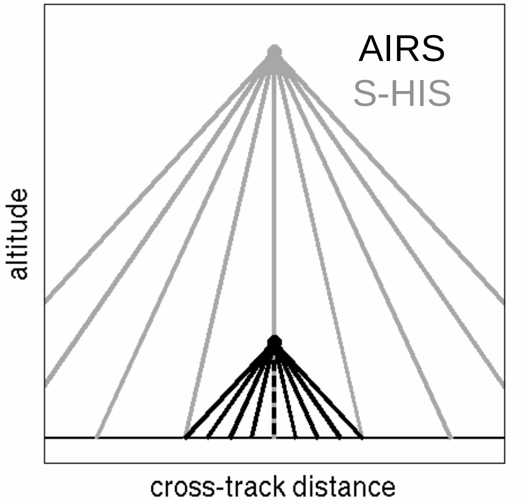
$$(Obs_{AIRS}-Calc_{AIRS}) \otimes SRF_{SHIS} - (Obs_{SHIS}-Calc_{SHIS}) \otimes SRF_{AIRS}$$

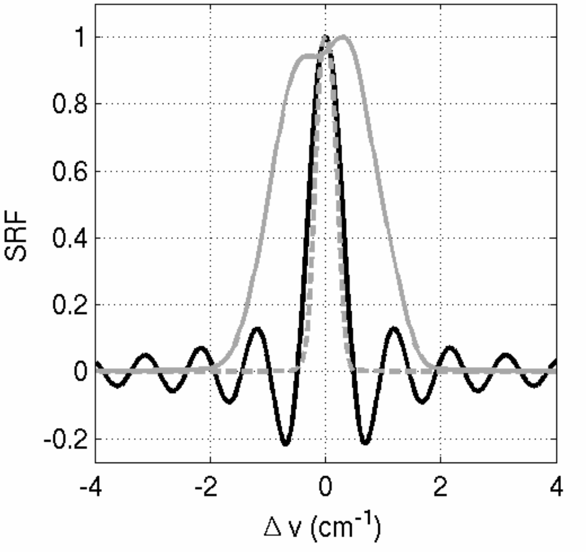


Spatial colocation is achieved by selecting scenes with low variability and covering the full AIRS FOVs with SHIS observations

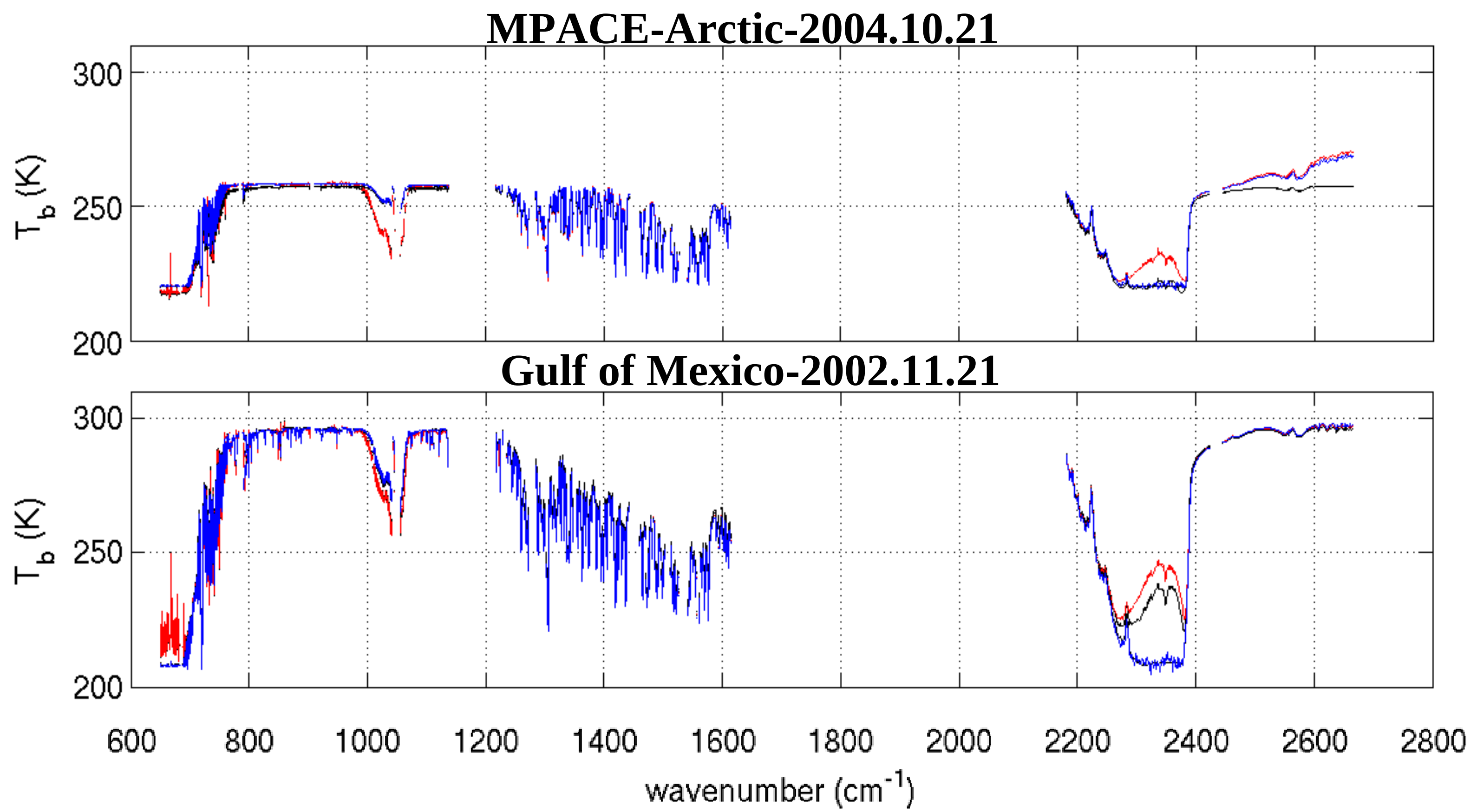
The double obs-calc method accounts for altitude and view angle differences and differences in instrument lineshapes

Channels with high sensitivity above the aircraft altitude are excluded from the final comparisons





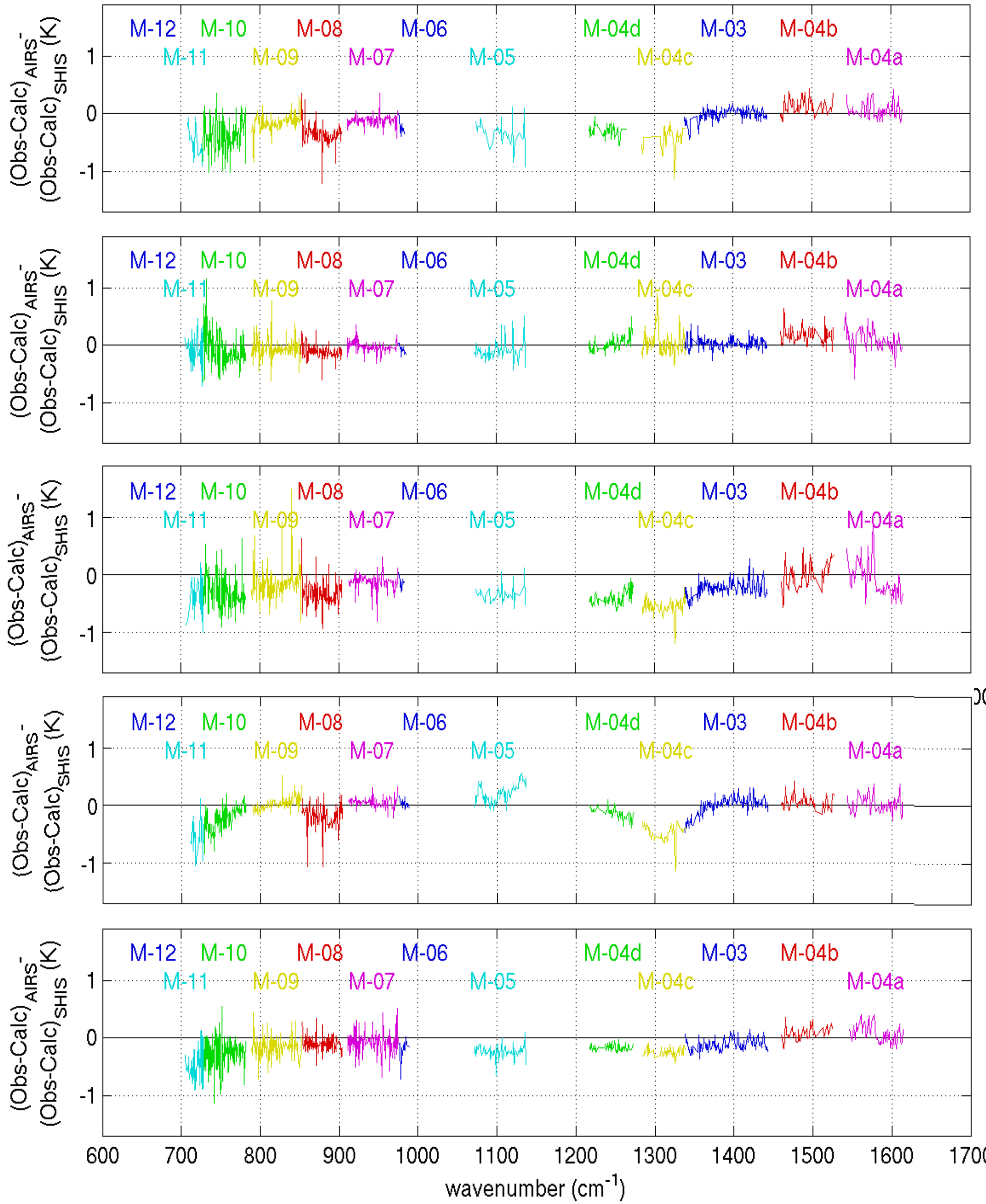
Example AIRS & SHIS Brightness T Spectra



Comparisons shown for AIRS spectral coverage—SHIS is continuous

AIRS-SHIS Summary

- Radiance validation is remarkably good
- Includes Tropical to Arctic atm.
- Extends over > 3 years
- HNO_3 creates 08, 04c, 04d biases
- Small 05=O_3?
- Small LW CO_2 diffs: above plane contributions?



2002.11.16
ARM-SGP

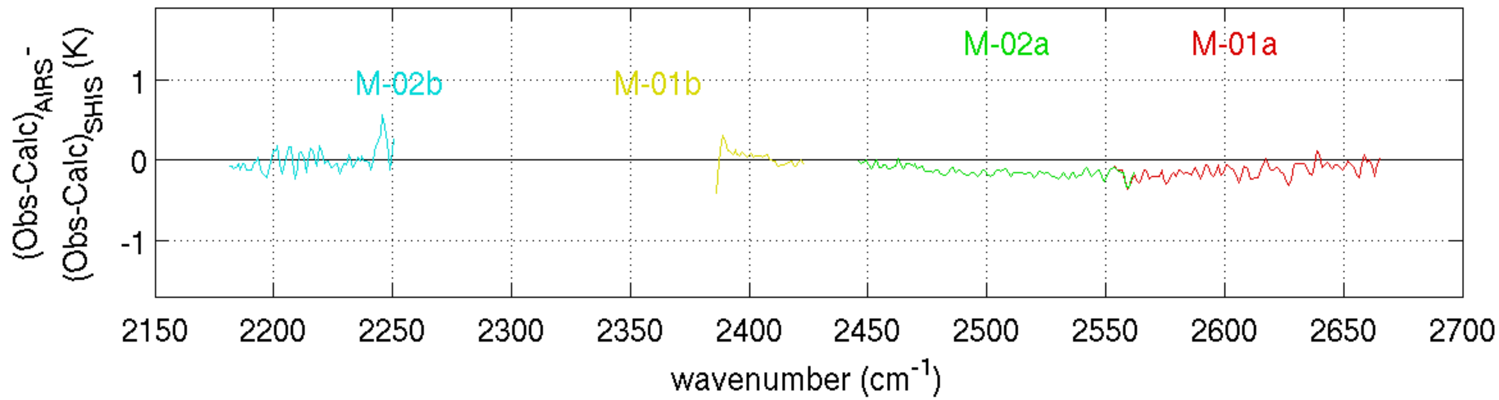
2002.11.21
Gulf of Mex

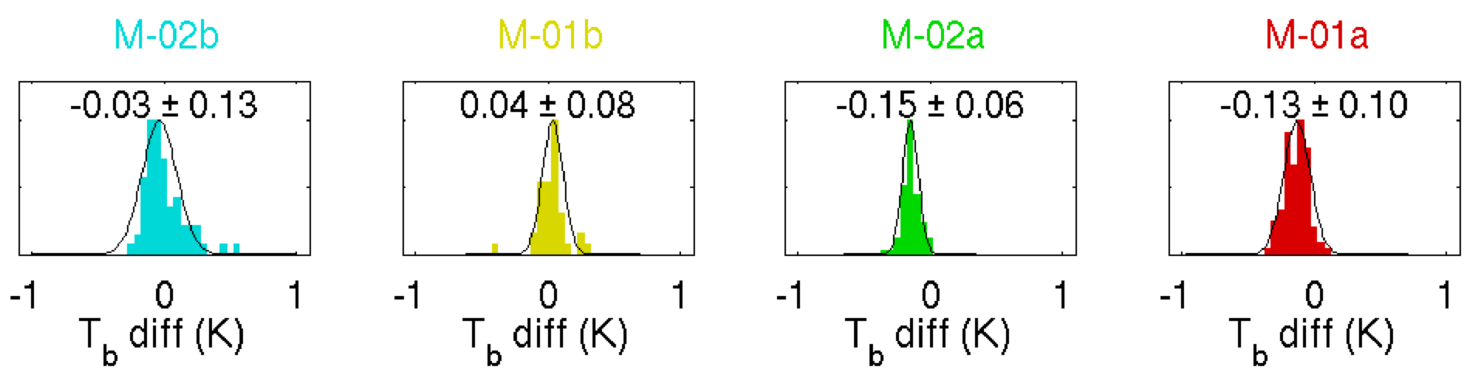
2004.09.07
Italy

2004.10.21
Arctic

2006.01.17
Tropical

AIRS-SHIS Summary: Shortwave (2004.09.07)





<u>1st Direct SW Radiance Validation</u>

Excellent agreement for night-time comparison from Adriex in Italy